SUMMARY PROJECT PLAN
TVA
AIRCRAFT PLUME SAMPLING

"MERCURY REACTIONS IN POWER PLANT PLUMES: PLANT BOWEN"

Research Objectives:

1) Develop and test an aircraft instrument package to measure the chemical and physical speciation of mercury in the plume of a full scale operational coal-fired power plant .

2) Perform field studies at operational power plants to determine how the mercury speciation changes from what is measured in the stack to what occurs in the plume as the plume is followed downwind and sampled at several points during the first few hours of transport time.

Summary of workplan

There have been very few attempts to study mercury in actual power plant plumes. Fortunately, some new research tools are improving the detection limit for airborne speciated mercury measurements. To attack the challenging problem of obtaining a detectable mercury sample in the airborne plume and the equally important task of quantitatively distinguishing mercury in the plume from background mercury levels, we will use the instrumented aircraft to measure the average concentration across the plume at several fixed distances downwind by repeated crosswind passes at each distance. TVA's fast NOx instrument will be used in conjunction with a fast acting clean air backflush system to trigger the sampling system to permit plume air into the inlet only while the aircraft is in the plume (based on a predetermined NOx threshold). When the aircraft is out of the plume, clean mercury-free backflush air will be switched into the sampling inlet. Analytical results will be corrected based on the fraction of time spent in and out of the plume.

At distances very close to the stack where the plume is extremely narrow it will be necessary to perform a "race track" flight pattern during which the airplane flies along the plume centerline to maximize time in plume. At greater distances downwind cross plume arcs will probably be appropriate. Real time feedback of elemental mercury measurements on board the aircraft will be used to determine if the sampling integration time is long enough to ensure an adequate margin above the detection limit. If initial samples at a given distance do not show enough sample, integration time will be increased to improve the signal-to-noise ratio. Samples will also be taken outside the plume to determine the background concentrations and speciation. Due to the rapid dilution that occurs with distance downwind, integration times will be increased as a function of expected dilution as the aircraft moves downwind. The total available flight time will limit the maximum possible integration time. The Twin Otter aircraft can remain aloft for four to five hours if necessary.

While the aircraft sampling is in progress stack measurements will be performed by UNDEERC and plume dilution chamber tests will be performed by Frontier Geosciences to help complete the mass balance and speciation of mercury from plant to plume.

Table 1 outlines the TVA aircraft mercury speciation instrumentation package.

Table 1. Aircraft Instrumentation Package.

Parameter	Time Resolution	Mfr. / Method	Expected Detection Limit
Gas phase Hg^0	Integration time will be adjusted as a function of distance downwind	Modified Tekran 2537A	Variable
Gas phase Hg^{2+}	Integration time will be adjusted as a function of distance downwind	Manual denuder method of Landis, Schaedlich, Stevens, and Prestbo with TVA adaptations for plume flight	Variable
Particulate Hg	Integration time will be adjusted as a function of distance downwind	Quartz filter sampling with analysis by Frontier Geosciences	Variable
Fast NO_x	1s	Modified TEII 42C	1ppb
SO_2	5s	UV Pulsed Fluorescence	0.5 ppb
Fast CO	1s	Aero-Laser GmbH model AL5002	<2.0 ppb
Ambient Temperature	5s	Platinum Thermistor	na
Cabin Temperature	5s	Thermocouple	na
Ambient Relative Humidity	5s	Capacitance Sensor	na
Altitude	5s	Barometric and GPS	na
Position	5s	Garmin 195 GPSMAP Global Positioning System and Flitemap Software	na
Data and Control	1s and 5 s	Campbell Scientific	na

In-flight plume and flight track information for the scientists and pilots is crucial in precision plume sampling missions. By combining the GPS and altitude information with the data recorded during the flight and displaying it in real time on board, the scientists will know the position and intensity of the target plume. Special attention will be paid in the study design to enhance the ability to measure mercury speciation and to differentiate plume mercury from mercury in the background air at the low levels expected in the plume. To optimize the ability to "see" the mercury plume, the field portion of the study is scheduled during a season when the background levels are low (i.e., not during mid-summer) in order to maximize the difference between the plume and background mercury concentrations. With these

considerations in mind the chosen time frame for the field measurements at Plant Bowen is October 7-21, 2002.